(12) UK Patent Application (19) GB (11) 2 322 998 (13) A

(43) Date of A Publication 09.09.1998

(21) Application No 9703547.1

(22) Date of Filing 20.02.1997

(71) Applicant(s)
Vodafone Limited
(Incorporated in the United Kingdom)
The Courtyard, 2-4 London Road, NEWBURY,
Berkshire, RG13 1JL, United Kingdom

(72) Inventor(s)
Gerry Cowan
John Boggis
Graham Rickett
Peter Zbaren

(74) Agent and/or Address for Service
Mathisen Macara & Co
The Coach House, 6-8 Swakeleys Road, Ickenham,
UXBRIDGE, Middlesex, UB10 8BZ, United Kingdom

(51) INT CL[6]
H04Q 7/38

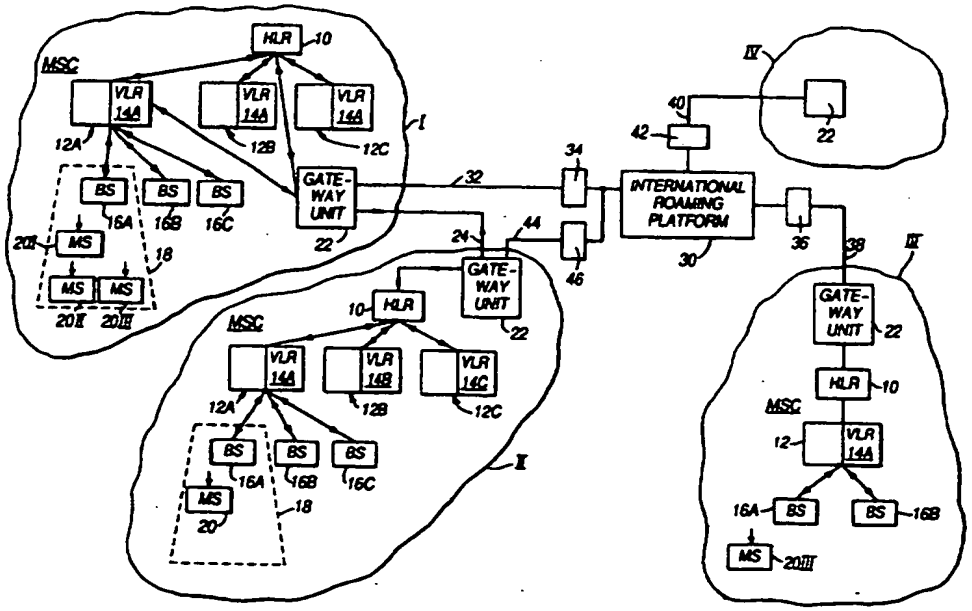
(52) UK CL (Edition P)
H4L LDSC L1H10

(56) Documents Cited
GB 2280085 A WO 95/32592 A1 WO 92/02103 A1

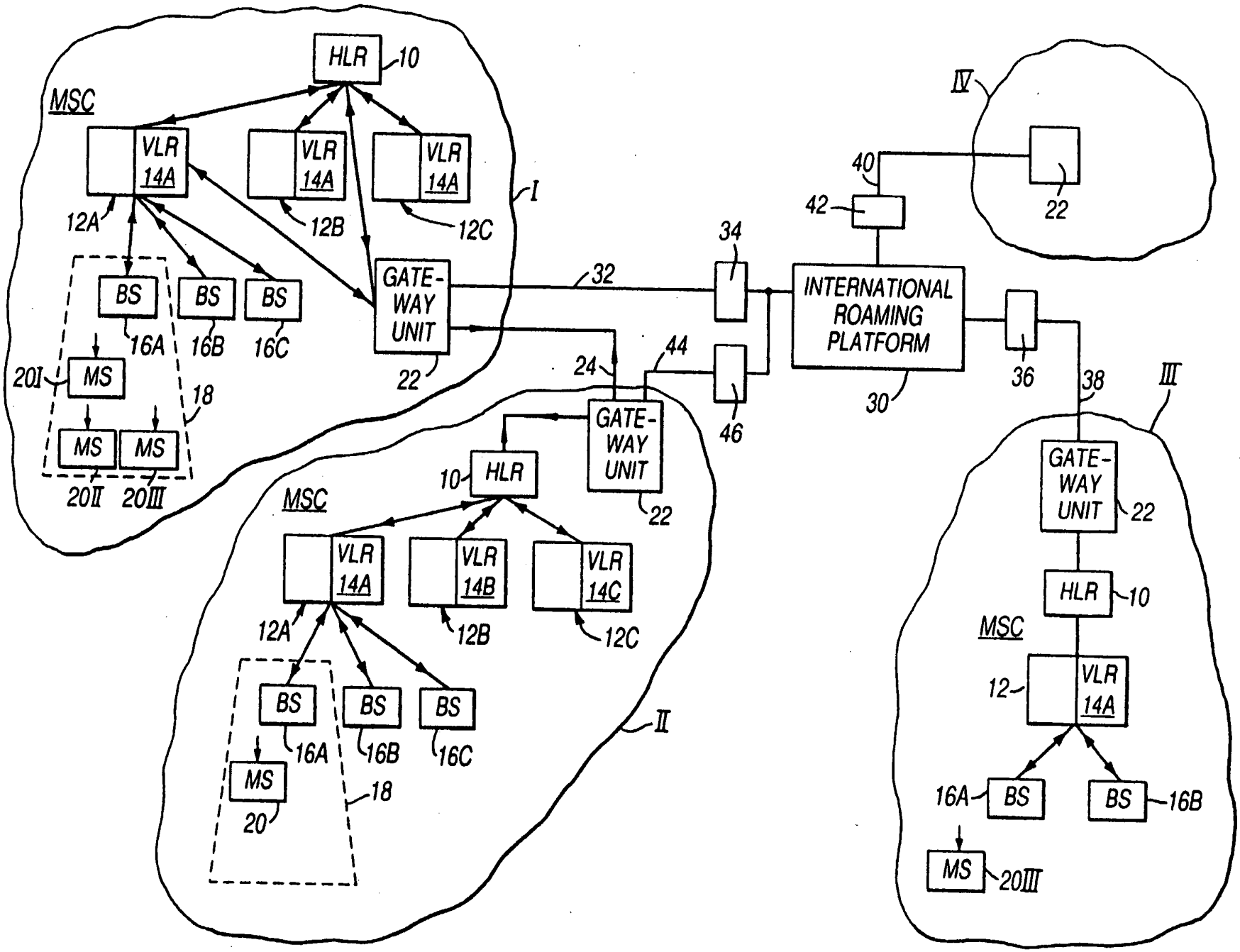
(58) Field of Search
UK CL (Edition O) H4L LDSC
INT CL[6] H04Q 3/00 7/38
ONLINE: WPI

(54) Abstract Title
Method of Interconnecting Communication Networks

(57) Networks III and IV have concluded service agreements with an international roaming platform (IRP 30) rather than bilaterally with networks I and III. When a subscriber (MS 20III) of one of these networks (III) is roaming in a visited network (I), a registration request is passed by the MSC (12A) of the visited network (I) to the international roaming platform (IRP 30) which checks that the visited network (I) and the home network (III) of the subscriber (MS 20III) have concluded service agreements with it and then passes the request to the home location register (HLR 10) of the home network (III). This home location register then produces authentication data which is transmitted by the international roaming platform (IRP 30) to the visited network (I) for authenticating the visiting subscriber (MS 20111). The subscriber's details are temporarily stored in the VLR (14A) of the visited network (I) and the subscriber's location is stored in the HLR (10) of the home network (III), thereby enabling the calls to be routed to and from the visiting subscriber (MS 20III). The calls themselves are not routed via the international roaming platform (IRP 30).



GB 2 322 998 A



1/1

TELECOMMUNICATIONS ARRANGEMENTS AND METHODS

The invention relates to telecommunication arrangements and methods. In one particular application, to be described in more detail below by way of example only, a telecommunication arrangement embodying the invention comprises GSM cellular telephone networks in which the subscribers to one of the networks can make and receive calls when temporarily present in the other network. However, the invention is not limited to such applications.

According to the invention, there is provided an interconnection unit for interconnecting each of a plurality of telecommunications networks with a selected one of the others thereof, the unit including means for receiving data relating to the subscriber to one of the networks ("home network") when present in another of the networks ("visited network") and passing that data to the visited network to enable that subscriber to make and receive calls via the visited network.

According to the invention, there is further provided a telecommunications arrangement, comprising a plurality of

geographically separate mobile telecommunications networks each having a respective set of subscribers; an interconnection unit connectable between predetermined ones of the networks; means in one (the "visited network") of the predetermined networks operative in response to data representing a registration request from a mobile telecommunications unit of the subscriber ("visiting subscriber") to another one (the "home network") of the predetermined networks while visiting the visited network to transmit the registration request to the interconnection unit; means in the unit for confirming that the visited network and the home network are included within the predetermined networks and for transmitting the registration request to the home network; and means in the home network for transmitting authentication data to the visited network via the interconnection unit for use in authenticating the mobile telecommunications unit in the visited network to enable calls to be made to and from that mobile telecommunications unit via the visited network.

According to the invention, there is also provided a method of interconnecting each of a plurality of telecommunications networks with a selected one of the others thereof, comprising the steps of receiving at a location geographically separate from the networks data relating to the subscriber to one of the

networks ("home network") while visiting another of the networks ("visited network") and passing that data to the visited network to enable that subscriber to make and receive calls via the visited network.

According to the invention, there is further provided a method of interconnecting predetermined ones of a plurality of geographically separate mobile telecommunications networks each having a respective set of subscribers, comprising the steps of responding at a geographical location separate from the predetermined networks to a registration request from a mobile telecommunications unit of the subscriber to one (the "home network") of the predetermined networks while visiting another one ("visited network") of the predetermined networks by confirming that the visited network and the home network are included within the predetermined networks; transmitting the registration request to the home network; and transmitting authentication data from the home network to the visited network via the geographical location for use in authenticating the mobile telecommunications unit in the visited network to enable calls to be made to and from that mobile telecommunications unit via the visited network.

Telecommunication arrangements and methods according to the invention will now be described, by way of example only, with reference to the accompanying diagrammatic drawing which is a block diagram of one of the arrangements.

The Figure shows four cellular telephone networks I,II,III and IV which are assumed to be in geographically separated regions (separate countries, for example). Each network is a GSM digital network.

The network I and its operation will now be briefly described.

The network contains a home location register (HLR) 10 which stores information relating to each subscriber of network I. Thus, it stores the subscriber's telephone number within the network, its International Mobile Subscriber identification (IMSI), information used for authentication purposes, and other data.

The network also includes several mobile switching centres (MSCs) 12A,12B and 12C, each of which includes a respective visitor location register (VLR) 14A,14B and 14C. Each MSC controls a number of base stations to which it is connected by land line or

suitable radio link. As shown in the Figure, MSC 12A controls base stations 16A,16B and 16C. Each base station transmits and receives radio signals within a respective geographical area or cell in which mobile or portable telephones may be located. The Figure shows the cell 18 associated with base station 16A, and also shows three mobile or portable telephones (mobile stations or MSs) 20I,20II and 20III. For clarity, the base stations for the MSCs 12A and 12B are not shown, and neither are the cells for the base stations 16B and 16C. In practice, of course, a network of reasonable size will have many more than three MSCs and may have more than one HLR.

Each MS comprises a portable telephone which is activated by means of a smart card (SIM), each SIM being particular to one subscriber and carrying information identifying that subscriber including the subscriber's IMSI, authentication data and other data. It will be assumed that MS 20I is a portable telephone which has been activated by the SIM of a subscriber to network I, and the operations carried out in relation to MS 20I will now be briefly considered.

When the MS 20I is powered up, a radio signal is transmitted to base station 16A and passed to MSC 12A. The MSC checks whether

the subscriber's details are currently stored in VLR 14A. It will be initially assumed that they are not. The MSC 12A therefore interrogates the HLR using the subscriber's IMSI to access the data stored in the HLR relating to that subscriber. In response to this interrogation, the HLR will transmit authentication data to the MSC 12A in "challenge" and "response" forms. Using this data, MSC 12A passes a "challenge" to the MS 20I through base station 16A. Upon receipt of this data, the MS 20I processes the data (in its SIM) and produces a "response" which is derived by the SIM via an encryption algorithm. If the response is correct, in relation to the "challenge" data, the MS 20I is deemed authenticated. The MSC 12A then requests subscription data from HLR 10 accordingly. The HLR then passes data relating to the subscriber to VLR 14A where it is stored, the data including information defining the type of service which may be provided to the subscriber (e.g. according to the level of the subscriber's subscription). MS 20I is now registered with MSC 12A and can make calls in the normal way via base station 16A and MSC12C.

MS 201 can also make calls when in cells controlled by the other base stations (16B and 16C) associated with MSC 12A, using the same information already stored in VLR 14A.

In addition, HLR 10 has recorded the current location of MS 20I. Incoming calls to network I intended for the subscriber can therefore be directed by the HLR to MSC 12A and thence to MS 20I. Such calls are directed to MSC 12A and hence to MS 201 by means of the subscriber's public telephone number.

The authentication process described above will be repeated at regular intervals while MS 20I remains activated and can also be repeated each time MS 20I makes or receives a call.

If MS 20I moves into a cell controlled by a base station associated with one of the other MSCs 12A and 12B, the registration process described above will have to be repeated, in order that the subscriber's details are transferred by HLR 10 into the appropriate VLR (14A or 14B). The subscriber's data previously stored in VLR 14A is deleted.

There are a large number of GSM networks throughout the world (over 200 at present). It is obviously desirable that a subscriber to one such network is also able to make and receive calls when present in one of the other networks. If this is to be possible, it is necessary for the visited network to be able to establish satisfactorily that the visiting subscriber is

properly authenticated and is operating within the terms of that subscriber's subscription. It is also necessary to ensure that the visited network can make a proper charge for calls made by the visiting subscriber and that this charge is eventually passed back to the subscriber. In order to enable the provision of these facilities, it will be assumed that networks I and II have concluded a bilateral agreement (a "roaming agreement") to enable a subscriber to either of these networks to make and receive calls when temporarily visiting ("roaming" in) the other network. This process will be briefly considered.

As shown in the Figure, network II is in principle arranged similarly to network I and corresponding items are similarly referenced.

It will be assumed that MS 20II (which is shown in cell 18 in network I) is an MS which has been activated by a SIM issued to a subscriber to network II. When this MS is powered up, a signal will be sent to base station 16A and thence to MSC 12A. The MSC will then check VLR 14A for the subscriber's data. It will be initially assumed that the data is not present.

The IMSI transmitted by MS 20II will include data identifying the

subscriber as being a subscriber to network II. MSC 12A will therefore be aware that the subscriber's data will not be present in HLR10 of network I. The MSC will therefore interrogate HLR 10 in network II by means of a suitable link to a gateway unit 22 in network I, a landline or other link 24 (such as provided by the relevant PTT), and a further gateway unit 22 in network II. Using the subscriber's IMSI, HLR 10 in network II will access the storage location respective to that subscriber and will respond initially by producing the "challenge" and "response" data in similar fashion to that described above. This data will be passed back to MSC 12A in network I and used to check the authentication of MS 20II in cell 18 of network I in the manner already explained in relation to MS 20I. Assuming that correct authentication takes place, the HLR 10 in network II continues by sending data to MSC 12A in network I defining the subscriber's service entitlement together with other data, all of which is then stored in VLR 14A of network I. In this way, MS 20II can now make calls while present in network I.

HLR 10 in network II will store the current location of MS 20II. Incoming calls for MS 20II will initially be received by network II - because it is to that network that they will be addressed by use of the subscriber's telephone number. However, HLR 10 of

network II will be able to re-direct such an incoming call to MS 20II and this call will be transmitted to the MS via MSC 12A in network I. For this purpose, MSC12A in network I will issue network II with a temporary public telephone number which is appropriate to network I and which directs calls to MS 20II in cell 18 in network I. This temporary telephone number is simply used by the two networks and is not known to the caller.

Calls to MS 20II in network I from network II are not passed to network I through the link 24, which is used simply for the passage of the setting up, authentication and other control data, but are passed by means of other suitable links (e.g. normal international telephone links).

Obviously, when MS 20I (which is controlled by a subscriber to network I) is visiting network II, the procedure which is followed, in order to enable MS 20I to make and receive calls while present in network II, is generally the same as that described above.

The roaming facility described above requires a bilateral roaming agreement to be concluded between networks I and II. In order to enable a subscriber to one network (e.g. network I) to be able

to roam into every other GSM network, there needs to be an appropriate agreement between network I and each of the other networks. If roaming is to take place as described above with reference to networks I and II, this would necessitate a separate bilateral roaming agreement between network I and each other network; correspondingly, each of the other networks would need to make bilateral agreements between themselves to enable their subscribers to inter-roam. However, it may not be appropriate or cost-effective for small networks (e.g. in small or low-populated countries) to conclude such a large number of bilateral agreements. The Figure therefore illustrates an alternative arrangement in accordance with the invention which will now be described. It will be assumed that networks III and IV are networks (e.g. small networks or networks in countries with low population) which have not concluded any bilateral roaming agreements, at least with networks I and II.

Network III is constructed generally similarly to networks I and II and corresponding items are similarly referenced. In the case of network III, however, it is assumed that it has only a single MSC 12 serving base stations 16A,16B,16C.... In principle, of course, it could have more MSCs. Network III shows an MS 20III which is assumed to be a portable telephone activated by a SIM

belonging to a subscriber to network III. When this MS is powered up in network III, the registration and authentication process which takes place is similar to that already described with respect to network I and involves the inter-change of data between the HLR 10 of network III and the MSC 12 of that network, until the subscriber's details are stored in VLR 14 of network III.

As stated, network III (and network IV) do not have roaming agreements with network I (or II). If a subscriber to network III, for example, roams into network I, it will therefore not be possible for his MS to become registered in network I in the same way as described above for MS 20II.

In order to overcome this problem, an "International Roaming Platform" (IRP) 30 is provided at a convenient geographical location. This geographical location is assumed to be outside the countries where networks I,II,III and IV are located. Networks III and IV will conclude service agreements with the IRP 30 - and will not have to conclude individual bilateral agreements with other GSM networks. Provided that the networks into which subscribers of networks III and IV wish to roam have also concluded service agreements with the IRP 30, roaming can

take place, as will now be described.

The operations carried out by the IRP 30 when a subscriber to network III roams into network I will first be considered. More specifically, it will be assumed that MS 20III is temporarily present (as shown in the Figure) in cell 18 of network I and is powered up.

When MS 20III in network I is powered up, an appropriate signal will be sent to MSC 12A in network I via base station 16A. The IMSI generated by MS 20III will include data identifying the subscriber as being a subscriber to network III. MSC 12A in network I will therefore be aware that the subscriber is not a "home" subscriber (that is, a subscriber to network I) and that the subscriber's data is not held in HLR 10 of network I. In fact, the MSC will be aware that the subscriber's details are held in network III and that this network has a service agreement with the IRP 30. An interrogation signal is therefore sent to gateway 22 of network I and is initially addressed to IRP30 with a destination address of network III. Thus, the gateway 22 of network I initially addresses the interrogation signal to IRP30 to which it is sent via a suitable link 32 (e.g. an international telecommunications link provided by the relevant PTT) where it

is received by a gateway unit 34 in the country where the IRP 30 is located and thence passed to the IRP 30.

On receipt of the interrogation signal, the IRP 30 checks to ensure that a service agreement has in fact been concluded between network III and the IRP. Assuming that this is so, IRP 30 now addresses the interrogation signal to network III and passes it through a gateway unit 36 and thence by a suitable link 38 (e.g. another international link provided by the relevant PTT) to the gateway unit 22 of network III whence it is transmitted to HLR 10 in network III.

In the manner already described, HLR 10 in network III accesses the appropriate storage location corresponding to the subscriber of MS 20III and generates relevant "challenge" and "response" data. This is sent back to MSC 12A in network I via the IRP 30, the links 38 and 32 and the appropriate gateway unit. MSC 12A in network I passes the "challenge" signal to MS 20III in cell 18. The corresponding response from the MS is passed back to MSC 12A in network I which compares it with the "response" data sent from network III. Assuming that a proper comparison occurs, MS 20III is regarded as authenticated and MSC 12A requests further information from HLR 10 in network III through IRP 30 and via

links 32 and 38 and the relevant gateway units. HLR 10 in network III responds by returning data to MSC 12A in network I defining the subscriber's entitlement to service, this data again being passed via IRP 30 and the links 32 and 38. All this data is temporarily stored in VLR 14A of network I so as to enable MS 20III in cell 18 to make calls in the manner already described. Furthermore, HLR 10 in network III has recorded the current location of MS 20III (within the coverage provided by MSC 12A). Any calls for MS 20III will be received initially by network III which then re-directs them to MS 20III in cell 18 of network I, again using a temporary network I public telephone number provided for this purpose by network I.

Calls for MS 20III in network I are not routed from network III to network I via the IRP 30 but are sent through another link which may, for example, be a normal international telecommunications link between the country of network III and the country of network I.

The registration process described above takes place each time the MS makes or receives a call. If MS 20III moves out of cell 18 into a cell controlled by one of the other MSCs 12B,12C in network I, it is again necessary for the registration process to

take place (and again via IRP 30).

The Figure does not illustrate network IV in any detail. In principle, though, it is of the same form as the other networks described. It will be apparent that subscribers to network IV can roam into network I in the manner just described for MS 20III, the registration and authentication process being carried out by IRP 30 with the data being transmitted to and from network IV via its gateway unit 22, a suitable link 40, and a gateway unit 42.

In an exactly similar fashion, subscribers to networks III and IV can roam into network II, the data being transmitted to and from network II via IRP 30, a link 44 and a gateway unit 46. Furthermore, of course, subscribers to networks I and II can roam into networks III and IV in the same way.

In this way, therefore, a network not wishing to conclude bilateral roaming agreements with every other, or some other, GSM networks can simply conclude a service agreement, instead, with the IRP 30. It will then in principle be possible for subscribers to those networks to roam into all other netwroks which have also concluded a service agreement with IRP30.

It will be appreciated that there may be more than one IRP 30. Thus, each IRP 30 may serve a particular group of networks - such as the networks in a particular geographical region or perhaps a large country or continent. If a subscriber to a network which has concluded a service agreement with one of these IRPs is roaming in a network which has concluded a service agreement with a different IRP, interrogation, authentication and the other control data is passed between the networks via both IRPs. In this case, a corresponding service agreement will have been concluded between the two IRPs. The operation is otherwise as already described.

It will be noted that the IRP 30 stores no information itself relating to any of the subscribers but merely checks whether the network of the roaming subscriber, and the visited network, have concluded service agreements with the IRP.

The IRP 30 may also be used to carry out certain other functions.

Firstly, it may be useful in detecting fraudulent or potentially fraudulent activity by subscribers.

It is normal in international roaming for network operators to

place a financial limit on the number of calls which a roaming subscriber may make within a predetermined period (e.g. each period of twenty four or forty eight hours). In certain countries, there may be two or even three GSM networks covering substantially the same geographical area. A fraudulent subscriber visiting such geographical area may be able to avoid these financial limits by disconnecting his MS from one of the networks (before the financial limit has been reached) and then activating it on one of the other networks. However, such "network hopping" will be apparent within the IRP 30 and can be noted as a possible indication of fraudulent activity. The IRP 30 will also be aware of the general geographical position of the subscriber. If the IRP notes that the subscriber's geographical position is generally unchanged, but the subscriber is nevertheless changing from one visited network to another, this may be indicative of fraudulent activity. The IRP 30 can thus be programmed to monitor such data and, ultimately, to refuse to pass further calls to or from that roaming subscriber.

Secondly, the IRP may be used to detect errors in the data passing through it and either then to correct them or to request a re-transmission of the data. It can monitor the frequency of such occurrences, thereby checking the quality of the links.

The IRP30 is also aware of the number of calls passing to and from each network. It can use this information to detect faults. Thus, if there appears to be an unusual gap in the frequency of calls to or from a particular network, this may indicate a fault or failure in the link between the IRP and that network and can be used to provide a warning of that fault and to initiate rectification action.

Although the description has stated that all the networks are similar GSM networks, this is not essential. The IRP 30 can in principle be used where one or some of the networks is different from the other. For example, one or some of the networks can be a network operating according to a specification which is different from the others (e.g. one network could be a Japanese PDC network or a United States digital network) and the others could be GSM networks. It is also not necessary for all the networks to be terrestrial networks: one or some of them could be a non-terrestrial network such as a satellite network. The IRP 30 could incorporate means for converting from the format applicable to one network to the format applicable to the other networks.

CLAIMS

1. An interconnection unit for interconnecting each of a plurality of telecommunications networks with a selected one of the others thereof, the unit including means for receiving data relating to the subscriber to one of the networks ("home network") when present in another of the networks ("visited network") and passing that data to the visited network to enable that subscriber to make and receive calls via the visited network.

2. A unit according to claim 1, in which the calls are not routed through the unit.

3. A unit according to claim 1 or 2, in which the said data includes identification data and data for authenticating the subscriber when present in the visited network.

4. A unit according to any preceding claim, in which the networks are similar terrestrial networks.

5. A unit according to claim 4, in which the networks are GSM networks.

6. A unit according to any one of claims 1 to 3, in which the networks are dissimilar terrestrial networks.

7. A unit according to any one of claims 1 to 3, in which at least one of the networks is a terrestrial network and at least one other one thereof is a non-terrestrial network.

8. A telecommunications arrangement, comprising a plurality of geographically separate mobile telecommunications networks each having a respective set of subscribers; an interconnection unit connectable between predetermined ones of the networks; means in one (the "visited network") of the predetermined networks operative in response to data representing a registration request from a mobile telecommunications unit of the subscriber ("visiting subscriber") to another one (the "home network") of the predetermined networks while visiting the visited network to transmit the registration request to the interconnection unit; means in the unit for confirming that the visited network and the home network are included within the predetermined networks and for transmitting the registration request to the home network; and means in the home network for transmitting authentication data to the visited network via the interconnection unit for use in authenticating the mobile telecommunications unit in the

visited network to enable calls to be made to and from that mobile telecommunications unit via the visited network.

9. An arrangement according to claim 8, in which the calls are not transmitted through the interconnection unit.

10. An arrangement according to claim 8 or 9, in which the networks are similar terrestrial networks.

11. An arrangement according to claim 10, in which the networks are GSM networks.

12. An arrangement according to claim 8 or 9, in which the networks are dissimilar terrestrial networks.

13. An arrangement according to claim 8 or 9, in which at least one of the networks is a terrestrial network and at least one other one thereof is a non-terrestrial network.

14. An arrangement according to claim 8 or 9, in which each of the networks is a cellular telephone network, and in which the visited network includes means operative to store data relating to the visiting subscriber temporarily in the visited network in

relation to the location where the visiting subscriber's mobile telecommunications unit is present, and means in the home network for storing the location in the visited network of the visiting subscriber's mobile telecommunications unit to enable calls received by the home network for that subscriber's mobile telecommunications unit to be routed to that unit in the visited network.

15. An arrangement according to any one of claims 8 to 14, including means in the interconnection unit responsive to repeated registration requests from the same visiting subscriber for detecting abnormal or fraudulent activity.

16. An arrangement according to any one of claims 8 to 15, including means in the interconnection unit responsive to registration requests from a particular visited network or for a particular home network and operative to detect abnormality in the frequency of such requests for indicating a possible fault condition.

17. An arrangement according to any one of claims 8 to 16, including means in the interconnection unit for detecting errors in data received by the unit and for correcting the errors or

requesting re-transmission o the data.

18. An arrangement according to claim 17, including means in the interconnection unit for detecting the frequency or number of the detected errors.

19. An arrangement according to any one of claims 8 to 18, including conversion means for converting data received from one of the home and visited networks into the data format corresponding to the other thereof.

20. An arrangement according to claim 19, in which the conversion means is part of the interconnection unit.

21. An arrangement according to any one of claims 8 to 20, in which two of the networks form a pair of the networks in which at least one of the networks in the pair is not a said predetermined network, and including means in a first one of the pair of networks which is operative in response to a registration request from a mobile telecommunications unit of a subscriber to the second one of the pair of networks while visiting the first network to pass that request to the second network otherwise than through the interconnection unit, means in the second network

responsive to the registration request to transmit authentication data to the first network otherwise through the interconnection unit for authenticating that mobile telecommunications unit, and means in the first network for temporarily storing data relating to that mobile telecommunications unit to enable calls to be routed to and from that mobile telecommunications unit in the first network.

22. A method of interconnecting each of a plurality of telecommunications networks with a selected one of the others thereof, comprising the steps of receiving at a location geographically separate from the networks data relating to the subscriber to one of the networks ("home network") while visiting another of the networks ("visited network") and passing that data to the visited network to enable that subscriber to make and receive calls via the visited network.

23. A method according to claim 22, in which the calls are not routed through the said location.

24. A method according to claim 22 or 23, in which the said data includes identification data and data for authenticating the subscriber when present in the visited network.

25. A method according to any one of claims 22 to 24, in which the networks are similar terrestrial networks.

26. A method according to claim 25, in which the networks are GSM networks.

27. A method according to any one of claims 22 to 24, in which the networks are dissimilar terrestrial networks.

28. A method according to any one of claims 22 to 24, in which at least one of the networks is a terrestrial network and at least one other one thereof is a non-terrestrial network.

29. A method of interconnecting predetermined ones of a plurality of geographically separate mobile telecommunications networks each having a respective set of subscribers, comprising the steps of: responding at a geographical location separate from the predetermined networks to a registration request from a mobile telecommunications unit of the subscriber to one (the "home network") of the predetermined networks while visiting another one ("visited network") of the predetermined networks confirming that the visited network and the home network are included within the predetermined networks; transmitting the

registration request to the home network; and transmitting authentication data from the home network to the visited network via the geographical location for use in authenticating the mobile telecommunications unit in the visited network to enable calls to be made to and from that mobile telecommunications unit via the visited network.

30. A method according to claim 29, in which the networks are similar terrestrial networks.

31. A method according to claim 30, in which the networks are GSM networks.

32. A method according to claim 29, in which the networks are dissimilar terrestrial networks.

33. A method according to claim 29, in which at least one of the networks is a terrestrial network and at least one other one thereof is a non-terrestrial network.

34. A method according to claim 29, in which each of the networks is a cellular telephone network, and including the step of temporarily storing data in the visited network relating to

the visiting subscriber and relating to the location in the visiting network where the visiting subscriber's mobile telecommunications unit is present, and storing in the home network the location in the visited network of the visiting subscriber's mobile telecommunications unit to enable calls received by the home network for that subscriber's mobile telecommunications unit to be routed to that unit in the visited network.

35. A method according to any one of claims 29 to 34, including the step of responding to repeated registration requests from the same visiting subscriber by detecting abnormal or faudulent activity.

36. A method according to any one of claims 29 to 35, including the step of responding to registration requests from a particular visited network or for a particular home network and by detecting abnormality in the frequency of such requests for indicating a possible fault condition.

37. A method according to any one of claims 29 to 36 including detecting errors in data received by the unit and correcting the errors or requesting re-transmission of the data.

38. A method according to claim 37, including the step of detecting the frequency or number of the detected errors.

39. A method according to any one of claims 29 to 38 including the step of converting data received from one of the home and visited networks into the data format corresponding to the other thereof.

40. A method according to any one of claims 29 to 39, in which two of the networks form a pair of the networks in which at least one of the networks in the pair is not a said predetermined network, and including the step of responding in a first one of the pair of networks to a registration request from a mobile telecommunications unit of a subscriber to the second one of the pair of networks while visiting the first network by passing that request directly to the second network, responding in the second network to the registration request to transmit authentication data directly to the first network for authenticating that mobile telecommunications unit, and temporarily storing in the first network data relating to that mobile telecommunications unit to enable calls to be routed to and from that mobile telecommunications unit in the visited network.

41. An interconnection unit for interconnecting at least two cellular telephone networks, substantially as described with reference to the accompanying drawing.

42. A telecommunications arrangement, substantially as described with reference to the accompanying drawing.

43. A method for interconnecting at least two cellular telephone networks, substantially as described with reference to the accompanying drawing.

The Patent Office

3/

Application No: GB 9703547.1 **Examiner:** Nigel Hall
Claims searched: all **Date of search:** 24 April 1997

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): H4L (LDSC)

Int Cl (Ed.6): H04Q 3/00, 7/38

Other: Online: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
A	GB 2280085 A (VODAFONE)	
A	WO 95/32592 A1 (SIEMENS)	
A	WO 92/02103 A1 (MOTOROLA)	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.